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This report describes the MTS High Temperature Testing System which was funded by AFSOR under the DURIP Program and installed at Drexel University. This testing system is dedicated exclusively for basic studies on the micromechanics behaviors of fiber-reinforced ceramic matrix composites under extreme temperature conditions. Owing to its very high temperature capability and versatility to perform tests in several testing configurations, this equipment has casted a positive impact on current AFOSR and other DOD funded research programs on ceramic-matrix composites conducted at Drexel University. It is the intention of this research group and the University to continue further developing our high-temperature mechanics capacity for the next generation of composite materials.

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MTS HIGH TEMPERATURE TESTING SYSTEM

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FINAL TECHNICAL REPORT

GRANT NO. AFOSR-88-0122

for

Director of Aerospace Sciences

Air Force Office of Scientific Research

Bolling AFB, DC 20332

January 1990

FOREWORD

This report describes the MTS High Temperature Testing System which was funded by AFOSR under the DURIP Program and installed at Drexel University. This testing system is dedicated exclusively for basic studies on the micromechanics behaviors of fiber-reinforced ceramic matrix composites under extreme temperature conditions. Owing to its very high temperature capability and versatility to perform tests in several testing configurations, this equipment has casted a positive impact on current AFOSR and other DOD funded research programs on ceramic-matrix composites conducted at Drexel University. It is the intention of this research group and the University to continue further developing our high-temperature mechanics capability for the next generation of composite materials.

INTRODUCTION

In 1989, a servohydraulic testing machine specifically rated for testing temperature up to 1500°C has been requisitioned through funding from AFOSR/ DURIP. This testing system is dedicated to support extensive research on the micro-mechanical behaviors of fiber-reinforced ceramic composite materials, now being conducted at Drexel University.

The background of our research stems from the need to understand the physical mechanisms of deformation and failure in ceramic-matrix composites under very high temperature conditions. The research requires three basic supporting components: namely (1) an in-house fabrication capability with the ability to control the important microstructural factors in the composites; (2) a mechanical testing system with the required high temperature capability and measurement sensitivity; and (3) a high-speed computer system for the mathematical simulation of the complex physical mechanisms as they are observed in experiment and/or inferred through theorization.

The requisitioned MTS high-temperature testing system was based on MTS Systems Corporation's Model 810 servohydraulic tester with an array of peripheral equipments specifically designed for high temperature testing of ceramic-matrix composites. Clearly, the requisition of this system fulfills one of the supporting requirements.

THE MTS TESTING SYSTEM

With funds provided by AFOSR and a matching fund from Drexel University, a system-package purchase arrangement was made with MTS Systems Corporation of Minneapolis, Minn. The package consisted the following major hardwares:

1. MTS Model 810 servohydraulic test system, with Model 458 MicroConsole, 10- ton actuator, 1 gpm servovalve;

2. MTS Model 657 high temperature furnace, with 1600°C maximum temperature and ± 2°C control stability, 225 mm heated length, rapid heating, adapting high temperature strain gage; and
3. MTS Model 686 high temperature tensile grip, 15 kip ramp and 7.5 kip fatigue, rated to 1500°C.

With a separate funding from the Benjamin Partnership Program (BFP) of the State of Pennsylvania, the following two related items were added to the total system:

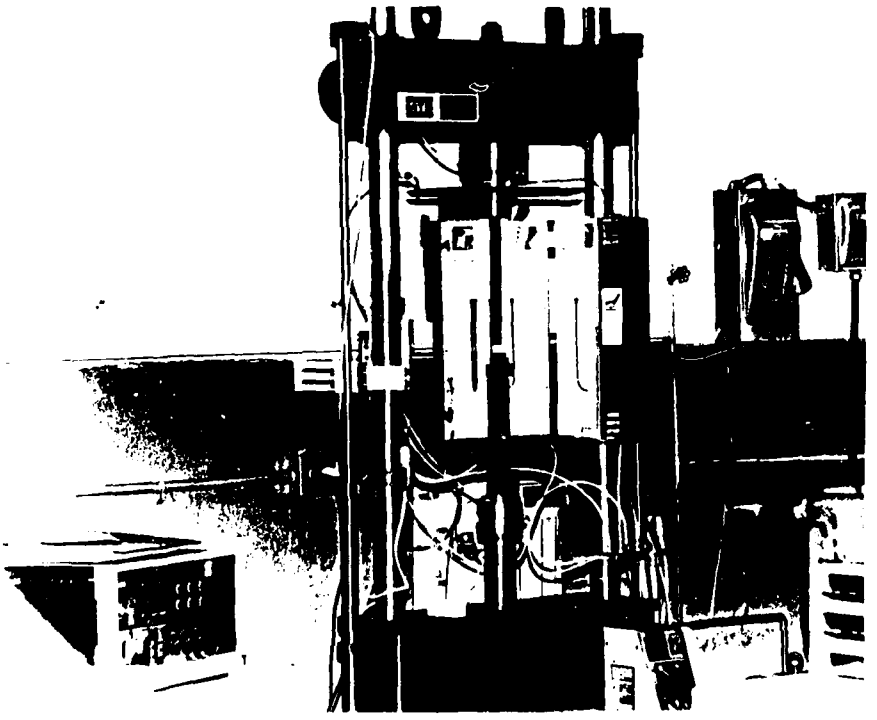
1. MTS Model 632 high temperature axial extensometer; and
2. MTS Model 642 high temperature 4-point bend fixture.

The MTS testing system is currently housed in Drexel's High Temperature Mechanics Laboratory, where a full-time technician is assigned to the care and maintenance of the laboratory. Since its installation in September 1989, 4-point bend tests have been routinely conducted under temperature conditions up to 600°C (the limitation of temperature is due to the test specimen). Test specimens capable of higher temperatures are now being fabricated in our Ceramic Composite Laboratory, and their testing will be conducted using the MTS system. In addition, plans are being made to acquire other high temperature test fixtures and data recording devises in order to conduct testing under tensile, compression and shear loading configurations.

CONCLUSIONS

The dedicated high temperature testing system provides the necessary capability to perform research into the micromechanisms of deformation and failure in ceramic-matrix composite materials. By making this testing system available has already enabled our research to reach yet another plateau in the science and

technology for the next generation of modern composite materials.



Photograph of the MTS tester setup - the main testing frame, the control console, the high temperature furnace and the 4-point bend fixture (inside the furnace).